

# **THE PERFORMANCE APPROACH TO CONSTRUCTION GOALS**

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## **ABSTRACT**

The performance approach, because it focuses directly and intelligently on the qualities desired of constructed facilities and enables innovation, is essential to the quality and economy of constructed facilities and the competitiveness of the industries of construction. Construction goals, expressing the benefits of improved performance, attract the attention and support of policy makers in the private and public sectors that is needed to focus and fund the research, development and deployment efforts required to achieve the goals. Collaborations in the United States between leaders of the industries of construction and federal agencies responsible for construction- related research and practice have led to formulation of construction goals and the program of performance-oriented R&D required to achieve the goals. Since both the needs for improved construction practices and the enabling technologies are internationally relevant, there are important opportunities for international collaborations in the funding and conduct of performance-oriented R&D addressing construction goals.

## **1. INTRODUCTION**

Perhaps, most of us here are motivated to improve the quality and economy of constructed facilities as an important means to improve human safety and quality of life. Perhaps, for most of us the performance approach is a means to the larger objective. Similarly, construction goals express the potential for improved knowledge of the performance of constructed facilities in a manner that can motivate policy makers, private and public, to support the research, development and implementation efforts required to achieve quality and economy of constructed facilities.

My talk describes a performance-oriented, goal-driven effort to focus and coordinate public and private research and development. Although similar activities are underway in other nations, for simplicity I limit my discussion to the U.S. program. It may be more than a model other national efforts might emulate and surpass. Potentially, it can become an

international program addressing goals important to everyone's quality of life, safety and competitiveness in the global marketplace.

## **2. VISION FOR CONSTRUCTION**

All of us involved in construction, whether designers, contractors, educators, manufacturers, owners, regulators, researchers or tradesmen, can take pride in the importance of our work to everyone's safety and quality of life, and the competitiveness of all industries. An appropriate vision for construction is:

- High quality constructed facilities support the competitiveness of all industries and everyone's quality of life.
- Construction leads in quality and economy in the global marketplace for investment. (Investors must choose construction over alternative investments (such as equipment or entertainment) as well as choosing among alternative suppliers of construction products and services.)
- The industries of construction and constructed facilities are safe and healthful, energy efficient, and sustainable in use of resources.
- Natural and manmade hazards do not cause disasters.

## **3. CONSTRUCTION GOALS**

In spite of the economic importance of constructed facilities and the industries of construction, relatively low emphasis is given to construction-related research by the private and public sectors in the U.S. U.S. private and public sector annual investment in research in construction is less than 0.5% of sales, whereas the all-industry average is 3.7% of sales. The picture appears to be similar in most other developed countries; Japan and Sweden are exceptions [1, 2].

This is representative of the conditions that inspired the President of the U.S., in 1993, to establish the National Science and Technology Council. Among the principal objectives of its Committee on Civilian Industrial Technology [3] are:

- Set national priorities for technologies that enhance U.S. industrial competitiveness.
- Coordinate federal R&D activities to minimize duplication.
- Involve the private sector in setting federal R&D priorities.
- Identify technology needs of industries particularly important to the U.S. economy.
- Encourage coordination with industry and academia.
- Monitor foreign technology advances.

The fundamental objective is not to increase government R&D, but to facilitate and increase industries' investments in highly competitive, innovative products and services. In light of its record, that is a particular challenge for the industries of construction!

In recognition of the importance of the industries of construction, the Subcommittee on Construction and Building (C&B) was formed in March 1994.

C&B, in order to demonstrate to policy makers in the private and public sectors the values of investments in innovation, and in consultation with leaders of the industries of construction [4], formulated goals for the life cycle performance of constructed facilities:

- 50% reduction in project delivery time.
- 50% reduction in operation and maintenance.
- 30% increase in productivity and comfort.
- 50% fewer occupancy-related illnesses and injuries.

- 50% less waste and pollution.
- 50% more durability and flexibility.
- 50% fewer construction illnesses and injuries.

The baselines are average performance of the industries in 1994. The targets are to have verified practices, capable of meeting the goals with reduced life cycle costs for owners, available for construction projects in 2003.

The construction goals are expressed in performance terms. An important challenge is to characterize and quantify the baselines and define measures for progress. C&B and its participating federal agencies are working with industry to establish these baselines and measures.

Discussions with industry since formulation of the goals in 1994 have shown that the goals generally are desirable and economically feasible. Recall, the baseline is average practice in 1994 and the target is the work of state of the art project teams in 2003. However, one goal appears clearly too low. Projects of members of the Construction Industry Institute currently operate at 1/7 of the industry-wide average for construction illnesses and injuries; the Institute's goal is to halve illnesses and injuries in its members' projects. Our goal for construction illnesses and injuries might better be a 90% reduction for projects applying state of the art technologies and practices for worker safety.

The construction goals are intended to express the desires of leaders of the industries of construction; they are not a government mandate to the industry. A focused workshop [5] with industry leaders defined the priorities of industry sectors and described the goals as National Construction Goals. C&B is encouraging industry to inform the federal agencies of the federal or federally-funded R&D needed to achieve the goals.

#### **4. ADDRESSING CONSTRUCTION GOALS**

C&B, drawing on many research fora and interactions with industry, has identified the following technical opportunities to obtain progress toward the goals:

- Information and decision technologies. The performance approach is greatly facilitated by advanced information technologies improving the flow of information to decision makers, and improving understanding of performance implications through multi-media information processing.
- Automation in design, construction and operation. The clarity of the performance approach is needed to exploit the potential of automation while avoiding unwanted side effects.
- High performance materials and systems. The performance approach is essential to definition of high performance for selection among alternative materials and systems.
- Environmental quality. The performance approach is needed to define and achieve objectives of energy conservation, air quality, and environmental sustainability. Needs and opportunities for remediation and use of contaminated sites provide particular challenges.
- Risk reduction technologies. Natural (fire, earthquake, wind, flood) and manmade (fire, terrorism, toxic discharges) hazards with increasing urbanization pose growing risks of losses requiring advanced, performance-based technologies for mitigation.
- Human factors knowledge. Performance ultimately is human functionality, safety, health and comfort; much research is needed to make human performance, as affected by the built environment, measurable and predictable. While the importance of human factors knowledge is evident, at present, many industry leaders are doubtful about our abilities to get valid and useful results from research. We should, at least, invest modestly and systematically in human factors research. When

successful techniques are evident, this will be a most fruitful area for performance-oriented research.

- Performance standards system. The system of performance standards and conformity assessment is essential to acceptance of innovations and for focus of resources on effectively achieving construction goals.

Industry leaders, in all of our interactions, have emphasized that private investment in innovations is severely inhibited by the existence of barriers to profit from investments. The barriers most often cited are:

- Lack of leadership in private and public sectors. The current U.S. Administration, with its establishment of the National Science and Technology Council and its assignment of unprecedented high priority to federal R&D for construction [6], has shown leadership. This is not yet reflected in Congressional responses to Administration requests for appropriations. The construction goals approach is attracting extraordinary support of leaders of industry for improved construction technologies and for removal of barriers to innovation.
- Regulatory barriers result from the myriad, uncoordinated approvals required for a project from local, state and federal regulatory authorities. These generate long and costly delays for conventional projects; fear of yet longer delays inhibit innovations. Our Administration encourages federal agencies to work together and with state and local agencies to streamline regulatory processes. This work is beginning.
- Liability from real or imputed failure of products to perform over the service life as the customer or other injured party expected discourages investment in innovations. Federal agencies, and other organizations, can provide low risk test beds to reduce liabilities for innovators.
- Adversarial relations in construction projects often discourage each participant from

innovating. Partnerships among project participants are needed.

- Financial disincentives for innovation exist because most construction organizations are too small to invest substantially in research, and because of the difficulty of protecting intellectual property when innovations are evident to observers and the workforce often changes employers. Some of these barriers can be overcome by consortia for innovation involving industry and researchers from academia and government.
- Lack of skilled workforce extends from shortages of replacements for retiring skilled tradesmen to the loss of knowledgeable corporate real estate executives from corporate downsizing. Solutions include education and training in conventional and innovative technologies, improvement of the work environment, automation and knowledge systems and the development of innovative professional and business services.

Knowledge from performance-oriented research must be transferred to practice so that it may be used to produce private and public benefits. Principal deployment activities include:

- Standards and practices are formulated to integrate new knowledge into the various contexts for its practical use. For the performance approach, this includes revising procedural and prescriptive standards to more accurately address their performance objectives.
- Education and training are required for the implementers of innovations. Collaborations between employers, employee organizations (such as professional societies and trade unions) and innovators are needed to fund and develop the educational syllabi.
- Demonstration projects, as noted above, can provide low risk test beds for innovations and show practical people the benefits to be obtained from and the

techniques required in implementation.

Leading U.S. private sector organizations have taken initiative to convene sector leaders to define: the goals most important to the sectors of the industries of construction, and the practices and research results that will be needed to achieve them. For each sector, many other organizations are participating with the lead organization. The sectors and their lead organizations are:

- Residential, the National Association of Homebuilders Research Foundation.
- Commercial/Institutional, the National Institute of Building Sciences.
- Industrial, the Construction Industry Institute.
- Public Works, the American Public Works Association.

The Civil Engineering Research Foundation is coordinating these private sector efforts and preparing a synthesis of their recommendations for guidance of the federal agencies participating in C&B. The findings are expected to include:

- Activities of the industries of construction to:
  - Remove barriers to innovation.
  - Develop baselines and measures of progress toward goals
  - Invest in improved products and services.
- Government Agencies and Researchers
  - Conduct R&D enabling private investments.
  - Help remove barriers to innovation.
  - Support deployment of innovations.

Independently, the American Institute of Architects, the International Association of Corporate Real Estate Executives, the International Facility Management Association, and Johnson Controls, Inc. have organized the National Summit on Building Performance to address the goal for improvement of the productivity of building occupants. From the



performance perspective, this is a most important goal.

## **5. POTENTIAL FOR INTERNATIONAL COLLABORATIONS**

Although the explicit motives of the U.S. industries of construction and the U.S. government for collaboration to achieve construction goals include the economic development of the U.S. and the international competitiveness of the U.S. industries of construction, we have strong incentives for international collaboration in the development of performance standards and provision of mutual recognition of conformance assessments. Indeed, four of thirty-eight topics identified for international collaboration at the 1996 international research symposium, “Engineering and Construction for Sustainable Development in the 21st Century,” deal with the performance approach [7].

Internationally-recognized performance standards will promote innovations by opening the world marketplace. All construction activities and constructed facilities will benefit from the best domestic and foreign innovations. We look forward to the knowledge and associations developed from participation in this symposium helping us all meet construction goals improving the safety, quality and economy of the world’s constructed facilities for the benefit of all humanity.

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